Appendix H: Energy Supply - detailed policy description/analysis

Overview

The Energy Supply (ES) sector includes emissions mitigation opportunities related to electrical energy supply options, including the generation, transmission, and distribution of electricity, whether generated through the combustion of fossil fuels or by renewable energy sources, and whether generated in a centralized power station or distributed generation facilities. Arizona has little oil and gas production, so the CCAG made no oil and gas recommendations.

The CCAG recommends a set of eight ES policy options that offer significant potential emission reductions. Three options quantified under the RCI sector are noted below but are not included in the ES sector totals in order to avoid double-counting. Similarly, the CCAG recommended in ES-4 that Arizona should advocate for a GHG cap and trade program at the regional or national level; values shown for it reflect a range of results over four scenarios. ES-10, Metering Strategies, is an enabling policy for greater penetration of clean distributed generation and energy efficiency technologies, so its reductions are quantified under other CCAG policy options.

Three policies are quantified as ES options that Arizona can implement on its own, including ES-1, Environmental Portfolio Standard/Renewable Energy Standard and Tariff; ES-6, Carbon Intensity Targets; and ES-12, Integrated Resource Planning. Because the purpose of ES-12 would largely be accomplished by (i.e., overlap with) the activities that would be undertaken to satisfy ES-1 and ES-6, only the results from ES-1 and ES-6 are included in the totals. Further, because either ES-1 or ES-6 would exhaust all available wind, biomass, and geothermal generation capacity within Arizona, GHG reductions from these resources are included only in ES-6 in order to avoid double-counting.[1]

In a further effort to eliminate possible double-counting, ES-1 and ES-6 were evaluated with respect to the reference case electricity demand forecast in order to take into account the fact that other ES and RCI measures (e.g., energy efficiency and distributed generation) will reduce the demand for grid electricity generation. Because the GHG reductions associated with ES-1 and ES-6 are directly related to total MWhs generated, GHG reductions for ES-1 and ES-6 were adjusted downward to reflect this lower demand. Specifically, GHG reductions achieved by the ES policies were reduced by the same percentage as the RCI policies reduced grid electricity generation in order to approximate the combined results of ES and RCI policies.

As summarized in the table below, these policy recommendations could lead to emissions savings from reference case projections of 17.9 $MMtCO_2e$ per year by 2020 and cumulative savings of 120.6 $MMtCO_2e$ from 2007 through 2020. The weighted average cost of saved carbon from the policy options for which quantitative estimates of both costs and savings were prepared was $20.57 per metric ton of CO_2 equivalent.

[1] ES-6 was chosen for relative ease of calculation; wind, biomass, and geothermal could have been included in ES-1 instead.

Energy Supply Sector
Summary of Results

#	Policy Name	Estimated 2010 GHG Savings ($MMtCO_2e$)	Estimated 2020 GHG Savings ($MMtCO_2e$)	Estimated Costs or Cost Savings Per Ton ($/$MMtCO_2e$)	Cumulative 2007-2020 GHG Savings ($MMtCO_2e$)	Level of CCAG Support
ES-1	Environ-mental Portfolio Standard / Renewable Energy Standard and Tariff	*The quantification below reflects the results provided by ES-1 when **integrated into the comprehensive package** of approved CCAG policy options.*				Majority
		3.0	8.7	$3.54	70.3	
		*The quantification below reflects the results provided by ES-1 when **isolated as a single, stand-alone** policy option.*				
		4.19	16.4	$6.48	116	
ES-3	Direct Renewable Energy Support (including Tax Credits and Incentives, R&D, and siting / zoning)	*This option is quantified under RCI-7, Distributed Generation / Renewable Energy Applications. Values are shown below for completeness, but not included in cumulative totals to prevent double-counting.*				Unanimous
		0.1	*2.1*	*$31*	*10*	
ES-4	GHG Cap and Trade	*Quantification for an aggressive national cap and trade scenario (Cap-Trade 4) as it would apply to Arizona's power sector is shown below. These values reflect the results of this scenario were it to be **integrated into the comprehensive package** of approved CCAG policy options.*				Unanimous
		0.12	*12.2*	*$18.45*	*63.2*	
		*Four national cap and trade scenarios were modeled as they would apply to Arizona's power sector in order to gauge their impact if implemented **as an isolated, single, stand-alone policy option**. Ranges of results are shown below. These values are not included in cumulative figures.*				
		-0.28 – 0.18	*2.0 – 18.5*	*$7.29 – $18.52*	*7 – 88*	

ES-6	Carbon Intensity Targets	*The quantification below reflects the results provided by ES-6 when* ***integrated into the comprehensive package*** *of approved CCAG policy options.*				Majority
		0.0	9.2	$44.33	50.3	
		The quantification below reflects the results provided by ES-6 when ***isolated as a single, stand-alone*** *policy option.*				
		0.0	14.0	$44.56	70	
ES-9	Reduce Barriers to Renewables and Clean DG	*This option is quantified under RCI-6, Distributed Generation / Combined Heat and Power. Values are shown below for completeness, but not included in cumulative totals to prevent double-counting.*				Unanimous
		0.4	*2.7*	*-$25*	*16*	
ES-10	Metering Strategies	*ES-10 is an enabling policy for RCI-6 and RCI-7; its quantification is incorporated into those options.*				Unanimous
ES-11	Pricing Strategies	*This option is quantified under RCI-8, Electricity Pricing Strategies. Values are shown below for completeness, but not included in cumulative totals to prevent double-counting.*				Unanimous
		1.1	*1.5*	*-$63*	*16*	
ES-12	Integrated Resource Planning	*The quantification below reflects the results ES-12 would provide if* ***implemented as a single, stand-alone*** *policy option. When* ***integrated into the comprehensive package*** *of CCAG-approved policy options, however, it would target the same activities as ES-1 and ES-6, so its reductions and savings would not be included in order to avoid double-counting.*				Unanimous
		0.06	5.4	-$2.50	28	
Total All Options		3.0	17.9	$20.57	120.6	*Note: Total includes onlyES-1 and ES-6.*

ES-1 Environmental Portfolio Standard / Renewable Energy Standard and Tariff (REST)

Policy Description:

An environmental portfolio standard (EPS) is a requirement that electric utilities must supply a certain percentage of electricity from environmentally friendly sources. An EPS differs from a Renewable Portfolio Standard (RPS) in that an EPS can include more options than renewables for meeting this requirement. Utilities can meet their requirements by purchasing or generating environmentally friendly electricity or by purchasing clean energy credits. By giving utilities the flexibility to purchase clean energy credits, a market in these credits would emerge that would provide an incentive to companies that are best able to generate clean energy, either through energy efficiency or renewables. Other options for meeting the requirement are possible, depending on how the EPS is structured. A provision could be included, for example, allowing funding for research and development to be applied toward meeting a utility's commitment.

Policy Designs:

The ES TWG analyzed five policy designs:

ES-1a(0): The likely changes by the Arizona Corporations Commission (ACC) to the EPS applied only to ACC-jurisdictional utilities: 5% in 2015, 15% in 2025; starting in 2007, 5% of the total renewable requirement must be from distributed renewables, increasing to 30% by 2011 and remaining at 30% in future years. Renewable Energy Credit (REC) trading is allowed, provided that all other associated attributes are retired when applying RECs to the Annual Renewable Energy Requirement. Out-of-state resources can be used provided that the necessary transmission rights are obtained and utilized.

ES-1a(1): **The ACC's likely changes to the EPS, with the Salt River Project (SRP) continuing with its proposed renewable investments**. The SRP has set a target to generate 15% of its electricity from renewable resources by 2025.

ES-1a(2): The ACC's likely changes to the EPS extended statewide.

ES-1b: Alternative scenario for ACC jurisdictional utilities: Starting with the current 1% target in 2005, increase 1% each year to 26% in 2025. Allow out-of-state renewables and REC trading.

ES-1c: Alternative scenario extended statewide.

- **Goal levels:** As noted above.-
- **Timing:** As noted above.
- **Parties:** Utilities as noted above.
- **Other:** Apply a least-cost approach, reflecting resource availability constraints, to determine which renewable energy resources and technologies would be used to meet the EPS (beyond the specific requirements laid out in the proposals).

Implementation Method(s):

- An EPS is usually implemented through a regulatory requirement (mandate) on the applicable utilities.

Related Policies/Programs in Place:

In the existing EPS, utilities (not including SRP) must generate a specified percentage of their total retail sales from renewable energy:

- Started in 2001 at 0.2% and increased annually to 1% in 2005; will increase to 1.1% in 2007. Expires in 2012.
- 2001–2003: 50% of EPS requirement must be solar electric; remainder can be other environmentally friendly technologies including no more than 10% R&D.
- 2004–2012: 60% of resources must be solar electric.
- Environmental Portfolio Surcharge of $0.000875 per kWh with caps by customer class.

Type(s) of GHG Benefit(s):

- CO_2: By creating a substantial market in renewable generation, an EPS can reduce fossil fuel use in power generation, correspondingly reducing CO_2 emissions.
- Black Carbon: To the extent that generation from coal and oil is displaced by renewables, black carbon emissions would decrease.

Estimated GHG Savings and Costs per tCO_2e:

Initial estimates were calculated – using the data sources, quantification methods, and key assumptions indicated below – as follows for CCAG review:

#	Policy	Scenario	Reductions ($MMtCO_2e$)			NPV (2006–2020) $ millions	Cost-Effective-ness $/tCO_2$
			2010	2020	Cumulative Reductions (2006 - 2020)		
ES-1	RE/Std/Tariff, ES-1a(0)	ACC Proposal alone	0.80	4.4	26	331	13
ES-1	RE/Std/Tariff, ES-1a(1)	ACC Proposal + SRP program	1.39	8.0	47	366	8
ES-1	RE/Std/Tariff, ES-1a(2)	ACC Proposal Statewide	1.42	7.7	46	538	12
ES-1	RE/Std/Tariff, ES-1b	Alternative Proposal for ACC Utilities	2.31	9.2	65	281	4
ES-1	RE/Std/Tariff, ES-1c	Alternative Proposal Statewide	4.19	16.4	116	752	6

The CCAG ultimately chose ES-1c, *Alternative Proposal Statewide*, as its recommendation for this policy option, and the steps described in the final report were taken to eliminate any potential overlap with other CCAG recommendations, because this could result in double-counting of costs and benefits. After eliminating potential overlaps, the following values were reported to the CCAG:

#	Policy	Scenario	Reductions ($MMtCO_2e$)			NPV (2006–2020) $ millions	Cost-Effective-ness $/tCO_2$
			2010	2020	Cumulative Reductions (2006 - 2020)		
ES-1	RE/Std/Tariff, ES-1c	Alternative Proposal Statewide	3.0	8.7	70.3	249	3.54

Data Sources, Methods, and Assumptions:

- **Data Sources:** CDEAC, WECC, EIA, EPA, Arizona Solar Energy Center, "*Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts*" by Sargent & Lundy.
- **Quantification Methods:** A simple capacity expansion model was developed in Excel specifically for this policy option. A trajectory of MWhs needed to satisfy the REST requirement was calculated, both for central renewable generation and distributed renewables. Renewable and fossil technologies were characterized in terms of cost

and operating profiles, and available resources in the State were also defined. Technologies include three classes of wind, concentrating solar power, geothermal, biomass, landfill gas, distributed solar PV, distributed solar thermal, conventional coal, integrated gasification combined cycle with carbon capture and storage (IGCC with CCS), natural gas combined cycle (NGCC), and natural gas combustion turbines (NGCT). It was assumed that 75% of the Renewable Energy Standard and Tariff (REST) requirement would be met through REC trading. It was also assumed that corresponding CO_2 reductions would be bundled with the RECs and count toward the emission reduction performance of this policy. A $5 per MWh REC price was assumed, which is consistent with available low-cost wind and other renewable resources in the West and is consistent with REC price assumptions in Integrated Resource Plans by various western utilities as reported in *Balancing Cost and Risk: The Treatment of Renewable Energy in Western Utility Resource Plans* (August 2005, Lawrence Berkeley National Laboratory). The model found the least-cost mix of renewables, constrained by available resources, to satisfy 25% of the central renewable requirement. An assumption that the distributed renewable requirement will be met by 50% solar PV and 50% solar thermal was made. Each renewable was also defined by the share of generation it displaces from NGCT, NGCC, and coal. The model then determines how many MWhs of NGCT, NGCC and coal would be displaced and the corresponding CO_2 emissions. The model also tracks the cost of generation for renewables and the displaced fossil; the present value of the difference is reported above.

- Key Assumptions: Cost and performance characteristics of generating technologies; resource availability; no demand response as a result of policy; no transmission and distribution modeled.

Key Uncertainties:

- As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are, first, related directly to the key assumptions listed above. If those assumptions are incorrect, then the results would change. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

- Reductions in overall energy consumption and the shift from fossil fuel generation resulting from an EPS would lead to reductions in criteria air pollutants and, consequently, lower health impacts and costs associated with those pollutants.
- Water use may be reduced through renewable versus combustion technologies.
- While much of the EPS requirement would come from low-cost renewables such as wind and biomass, meeting the requirement may lead to a moderate increase in direct costs to utilities implementing the EPS policy and a small increase in overall electricity system cost for Arizona. At the same time, investment in new technologies resulting from the EPS may spur economic development and corresponding job growth, and to the extent the renewable energy is derived from Arizona-based capital projects, generate additional local tax revenues.

Feasibility Issues:

- None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Majority.

Barriers to Consensus:

Virtually all CCAG members concur with the idea of an EPS, but some felt that the majority option might be too aggressive. Some members of the CCAG affiliated with entities regulated by the ACC were not in a position to publicly support EPS requirements which depart from those being pursued by the ACC.

ES-3 Direct Renewable Energy Support (including Tax Credits and Incentives, R&D, and siting/zoning)

Policy Description:

The purpose of this suite of policies is to encourage investment in renewables by providing direct financial incentives and by removing siting and zoning barriers to renewable energy facilities. Funding R&D also encourages development of new renewable technologies.

Direct renewable energy support can take many forms including: 1) direct subsidies for purchasing/selling renewable technologies given to the buyer/seller; 2) tax credits or exemptions for purchasing/selling renewable technologies given to the buyer/seller; 3) tax credits or exemptions for operating renewable energy facilities; 4) feed-in tariffs, which are direct payments to renewable generators for each kWh of electricity generated from qualifying renewable facilities; and 5) tax credits for each kWh generated from a qualifying renewable facility.

R&D funding can be targeted toward a particular technology or group of technologies as part of a State program to build an industry around that technology and/or to set the stage for adoption of the technology in the State. R&D funding can also be made available to any renewable or other advanced technology through an open bidding procedure (i.e., driven by bids received rather than by an effort to develop a particular technology). Funding can also be provided for demonstration projects to help commercialize technologies that have already been developed but are not yet in widespread use.

Many renewable energy technologies – particularly wind power – face siting and zoning obstacles. Often the best wind resources are also in scenic areas, which can spur opposition to development. Further, they may not be near existing transmission lines. Policies can be developed to help overcome these barriers.

Policy Design:

This policy was identified by both ES and RCI TWGs. In order to avoid duplicative effort, it was analyzed under RCI-7, Distributed Generation/Renewable Energy Applications.

- **Goal levels:** As noted above.
- **Timing:** As noted above.
- **Parties:** A state agency would administer the direct subsidies, and individuals, commercial enterprises, and industrial enterprises would receive them. Utilities would administer a feed-in tariff under supervision of a state agency, and independent power producers operating qualifying renewable facilities would receive the payments. A state agency would administer R&D funding through a public-private partnership with companies and research institutions.

  Note that a source of funds to cover subsidies or other support would have to be determined.

Implementation Method(s):

- Funding mechanisms and or incentives
- Pilots and demos
- Research and development

Related Policies/Programs in Place:

- Personal income tax credit for renewables, amounting to 25% of the cost of installation up to a maximum of $1,000.
- Sales tax exemption for up to $5,000 of the cost of a renewable installation.

Type(s) of GHG Benefit(s):

- CO_2: By providing a financial incentive for renewable generation and helping overcome siting and zoning barriers facing renewables, more renewable facilities would be installed and more electricity from renewables would be generated. This low-carbon generation would displace generation from fossil fuels and reduce carbon emissions. By funding R&D, new or improved renewable technologies would be developed or commercialized, leading to even more installations of renewables and a corresponding reduction in carbon emissions in the long term.
- Black Carbon: To the extent that generation from coal and oil would be displaced by renewables, black carbon emissions would decrease.

Estimated GHG Savings and Costs per tCO_2e:

- This option is quantified under RCI-7, Distributed Generation/Renewable Energy Applications

Data Sources, Methods, and Assumptions:

- See RCI-7, Distributed Generation/Renewable Energy Applications.

Key Uncertainties:

- See RCI-7, Distributed Generation/Renewable Energy Applications.

Ancillary Benefits and Costs:

- Reductions in overall electricity consumption and the shift from fossil fuel generation as a result of new renewables would lead to reductions in criteria air pollutants and, consequently, health costs associated with those pollutants.
- Water use may be reduced through renewable versus combustion technologies.
- Renewable resources may be less risky than fossil resources because they are not subject to unexpected changes in the price of fossil fuels.
- The operating costs of renewable generation – primarily maintenance – are spent locally and are a direct boost to local and state economies, whereas the primary cost of operating fossil fuel plants – fossil fuels – may go out of state and not contribute to the local or state economy.

Feasibility Issues:

- None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

ES-4 GHG Cap-and-Trade Program

Policy Description:

A cap-and-trade system is a market mechanism in which CO_2 emissions are limited or capped at a specified level, and those participating in the system can trade permits (a permit is an allowance to emit one ton of CO_2) in order to reduce the costs of compliance. For every ton of CO_2 released, an emitter must hold a permit. Therefore, the number of permits issued or allocated is, in effect, the cap. The government can give permits away for free (according to any of many different criteria) to those participating in the system or even to those who are not, auction them, or a combination of the two. Participants can range from entities within a single sector to the entire economy and can be implemented upstream (at the level of fuel extraction or import) or downstream (at the points where fuel is consumed).

Policy Design:

The CCAG recommendation is to encourage the governor to explore development of a regional or national, economy-wide cap-and-trade program.

Some CCAG members also expressed interest in exploring a cap-only program for Arizona, but implementation of such a program would have effectively echoed other policy options considered, such as an EPS/REST (ES-1). .

The ES TWG's investigation primarily concerned electric sector impacts of an economy-wide GHG cap-and-trade program implemented on a regional (multi-state) or preferably a national basis. The TWG considered existing studies of such programs to infer what the impact in Arizona may be. The TWG also considered the comparative costs of reaching a given cap on a national or a regional basis.

Other issues cited by the TWG as important in the design of a GHG cap-and-trade system include:

- Applicability (i.e., sources and sectors included)
- Gases included
- Permit allocation rules (method; options for new market entrants)
- Generation-based or load-based; leakage concerns
- Linkage to other trading systems
- Banking and borrowing; early reduction credits
- Inclusion of emission offsets (within or outside covered sector(s) or geography)
- Incentive opportunities (e.g., interaction with other pollution regulations like Pennsylvania's EDGE program).

For illustration of the potential impact of various levels of a national cap-and-trade program, four national cap-and-trade scenarios (described below under Goal Levels) were considered.[2] The GHG reductions and costs reported further below reflect regional power-sector results that have been scaled to approximate what would occur in Arizona.

- **Goal levels:**

Case Name	Carbon Intensity (CI) Reduction Goal (% per year)		Safety-Valve Price (2004 dollars per tCO_2e)		Other
	2010-2019	2020-2030	2010	2030	
Cap-Trade 1	2.4	2.8	$ 6.16	$ 9.86	Greenhouse gas cap-and-trade system with safety valve.
Cap-Trade 2	2.6	3.0	$ 8.83	$ 14.13	
Cap-Trade 3	2.8	3.5	$ 22.09	$ 35.34	
Cap-Trade 4	3.0	4.0	$ 30.92	$ 49.47	

- **Timing:** As noted above.
- **Parties:** Economy-wide.

Implementation Method(s):

- A market-based mechanism with underlying regulatory obligation.
- Arizona cannot implement a regional or national cap-and-trade program on its own, but it can work with other jurisdictions and federal officials toward this outcome.

Related Policies/Programs in Place:

- No GHG cap-and-trade system is in place in Arizona.

Type(s) of GHG Benefit(s):

- CO_2: A cap-and-trade system is a direct limit on CO_2 emissions. The level of the cap determines reductions.
- Black Carbon: To the extent that electric generation from coal and oil would decline under a cap-and-trade system, black carbon emissions would also decrease.

[2] These scenarios were consistent with scenarios identified and published by the U.S. Energy Information Administration (EIA) in March 2006.

Estimated GHG Savings and Costs per tCO_2e:

Arizona doesn't have the authority alone to implement a national or regional cap-and-trade program. However, the CCAG wanted to have some awareness of what the impacts of such a program might be in Arizona. Accordingly, the ES TWG investigated power-sector GHG reductions and costs under the four EIA cap-and-trade scenarios noted above. This investigation yielded the following results:

#	Policy	Scenario	Reductions ($MMtCO_2e$)			NPV (2006–2020) $ millions	Cost-Effective-ness $/$tCO_2$
			2010	2020	Cumulative Reductions (2006-2020)		
ES-4	Cap - Trade 1	2.4%–2.8% CI, $6.16–$9.86 safety valve	-0.28	4.4	7	51	7
ES-4	Cap - Trade 2	2.6%–3.0% CI, $8.83–$14.13 safety valve	0.17	2.0	9	85	10
ES-4	Cap - Trade 3	2.8%–3.5% CI, $22.09–$35.34 safety valve	-0.20	16.5	63	1096	17
ES-4	Cap - Trade 4	3.0%–4.0% CI, $30.92–$49.47 safety valve	0.18	18.5	88	1630	19

Data Sources, Methods, and Assumptions:

- **Data Sources:** Data for the electricity modeling done for this analysis comes from the U.S. Energy Information Administration (EIA) and can be found within the National Energy Modeling System (NEMS). Data in NEMS includes representation of the existing generation, transmission and distribution system down to the unit level. NEMS also includes data that characterizes new plants that the model can choose to build to meet projected demand growth. EIA's publication entitled *"Assumptions to the Annual Energy Outlook"* details key assumptions in the current version of the model. EIA also publishes NEMS model documentation.
- **Quantification Methods:** The modeling presented here was done by the Energy Information Administration in a Congressional Service Report from March 2006 entitled "*Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals*." The scenarios are listed above and reflect national cap-and-trade policies. Impacts were scaled to approximate the results in Arizona for the four scenarios presented here in the same way as for the NEMS modeling conducted specifically for this process. For the cap-and-trade scenarios, the cost of the policies was approximated by multiplying CO_2 reductions by one-half of the market price for CO_2 allowances. (The allowance price is the marginal price of allowances needed to produce the reported emission reductions; the actual cost of each ton of reductions ranges from zero up to the price of allowances. For simplicity, the actual cost is assumed to be an average of the high (the market clearing price) and low (zero) cost of reductions, which equals one-half of the market clearing price). Costs are reported as a net present value of the stream of costs from 2006 to 2020. The number of tons reduced was determined by calculating the difference between the emissions in

the policy case and those from a reference case NEMS run. Because the NEMS model is a national model with multi-state regions (Arizona is within the Rocky Mountain Power Area), the results for Arizona were derived from results in the region. Regional emissions and cost results were assigned pro rata according to the share of Arizona generation within the region.

- Key Assumptions: Any analysis of state-level policies using the National Energy Modeling System (NEMS) from the U.S. Energy Information Administration should be weighed carefully. NEMS is a national model that consists of 13 regions. State policies cannot be implemented explicitly within NEMS, and the State-specific impacts cannot be known explicitly. Assumptions must be made about the impact of policies at the State level by assigning shares of regional results. In reality, the State-level changes resulting from the policies implemented may differ substantially from the change in the region overall.

Key Uncertainties:

- As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are related directly to the key assumptions and quantification methods listed above. If those assumptions were changed, then the results would change. Other uncertainties include the forecast price of fossil fuels and future growth in demand for electricity.

Ancillary Benefits and Costs:

- The shift from fossil fuel generation as a result of a cap-and-trade system would lead to reductions in criteria air pollutants and, consequently, health impacts and costs associated with those pollutants.
- Water use may be reduced through renewable versus combustion technologies.
- Allowing “offsets” from outside the capped sector can create the incentive to quantify and reduce GHG emissions from sources in other sectors.
- The shift in fossil fuel resources as a result of a cap-and-trade system could have unintended consequences, including increased cost of natural gas and need for additional natural gas infrastructure.

Feasibility Issues:

- None cited, apart from the far greater feasibility of a national or regional cap-and-trade system.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

The CCAG’s explicit preference was for a cap-and-trade program a) implemented at the national level, and b) covering the widest spectrum of economic sectors possible. Consensus would have been unlikely regarding an Arizona-only cap-and-trade program.

ES-6 Carbon Intensity Targets

Policy Description:

Rather than a fixed cap on carbon emissions, a carbon intensity target is a limit on the ratio of carbon emissions to a measure of output. Absolute emissions can increase as output increases. Measures of output are clear for some sectors – like electricity generation (e.g., MWh) – but can difficult for other sectors (e.g., manufacturing). One measure of output for other sectors could be dollars equal to the value of the output.

Policy Design:

Under this policy, Arizona would implement a mandatory carbon intensity target that begins in 2010 (i.e., equal to carbon intensity in 2010) and that declines by 3% annually through 2025. The annual carbon intensity target would be translated into a cap, and trading would be allowed under that cap.

- **Goal levels:** As noted above.
- **Timing:** As noted above.
- **Parties:** Utilities and electric generators.

Implementation Method(s):

- A market based mechanism with underlying regulatory obligation.

Related Policies/Programs in Place:

- No carbon intensity target is currently in place in Arizona.

Type(s) of GHG Benefit(s):

- CO_2: A carbon intensity target may or may not reduce absolute CO_2 emissions. A stringent intensity target is more likely to lead to reductions than a lenient target. A less stringent target may curb growth in emissions, but not reduce absolute emissions.
- Black Carbon: To the extent that generation from coal and oil would decline under a carbon intensity target, black carbon emissions would also decrease.

Estimated GHG Savings and Costs per tCO_2e:

Using the data sources, quantification methods, and key assumptions described below, initial estimates were calculated:

#	Policy	Scenario	Reductions ($MMtCO_2e$) 2010	2020	Cumulative Reductions (2006-2020)	NPV (2006–2020) $ Millions	Cost-Effective-ness $/tCO_2$
ES-6	Carbon Intensity Target	Intensity improvement of 3%/year 2010-2025	0.00	14.0	70	3119	44

The CCAG ultimately selected this policy option as one of its recommendations. The steps described in the final report were then taken to eliminate any potential overlap with other CCAG recommendations, because this could result in double-counting of costs and benefits. After eliminating potential overlaps, the following values were reported to the CCAG:

#	Policy	Scenario	Reductions ($MMtCO_2e$) 2010	2020	Cumulative Reductions (2006-2020)	NPV (2006–2020) $ Millions	Cost-Effective-ness $/tCO_2$
ES-6	Carbon Intensity Target	Intensity improvement of 3%/year 2010-2025	0.00	9.2	50.3	2231	44.33

Data Sources, Methods, and Assumptions:

- **Data Sources:** CDEAC, WECC, EIA, EPA, Arizona Solar Energy Center, "*Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts*" by Sergeant & Lundy.
- **Quantification Methods:** A simple capacity expansion model was developed in Excel specifically for this policy option. Renewable and fossil technologies were characterized in terms of cost and operating profiles, and available resources in the State were also defined. Technologies include three classes of wind, concentrating solar power, geothermal, biomass, landfill gas, conventional coal, integrated gasification combined cycle with carbon capture and storage (IGCC with CCS), natural gas combined cycle (NGCC), and natural gas combustion turbines (NGCT). The reference case forecast of electricity generation was the starting point for this analysis. It was assumed that existing resources would continue to operate in the State over the analysis period. Generation from existing resources was subtracted from the reference forecast of total generation to provide a new generation forecast. The model then found the least-cost mix of new generation needed, subject to the constraint that resulting CO_2 emissions not exceed the limit imposed by the carbon intensity target. The model tracks cost and CO_2 emissions associated with this new generation. The model was also run without constraints in order to develop a reference case. The difference in CO_2 emissions and total cost of generation between the policy case and the reference case was then calculated. These results are reported above.

- **Key Assumptions:** Cost and performance characteristics of generating technologies now and in the future; resource availability; no demand response as a result of policy; no transmission and distribution modeled.

Key Uncertainties:

- As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are, first, related directly to the key assumptions listed above. If those assumptions were changed, then the results would change. Other uncertainties include the forecast price of fossil fuels and growth in the demand for electricity.

Ancillary Benefits and Costs:

- The shift from fossil fuel generation as a result of a carbon intensity target would lead to reductions in criteria air pollutants and, consequently, health impacts and costs associated with those pollutants.

Feasibility Issues:

- Although no significant hurdles to the effective adoption of this policy are evident, Arizona would be among the first states to implement such a program.

Status of Group Approval:

Completed.

Level of Group Support:

Majority.

Barriers to Consensus:

Some CCAG members were concerned that a carbon intensity regulatory program has little precedent elsewhere in the U.S. and thus represents relatively uncharted ground. Further, members of the CCAG affiliated with entities regulated by the ACC were not in a position to publicly support requirements which depart from those being pursued by the ACC.

ES-9 Reduce Barriers to Renewables and Clean Distributed Generation (DG)

Policy Description:

Remove barriers to renewables and clean distributed generation (DG) including: commercialization barriers; price distortions; failure of the market to value the public benefits of renewables; failure of the market to value the social cost of fossil fuel technologies; and market barriers such as inadequate information, institutional barriers, high transaction costs because of small projects, high financing costs because of lender unfamiliarity and perceived risk, "split incentives" between building owners and tenants, and the fact that transmission costs are often higher for renewables.

Policy Design:

This policy was identified by both ES and RCI TWGs. In order to avoid duplicative effort, it was analyzed under RCI-6, Distributed Generation/ Combined Heat and Power.

Policies to remove these barriers include: standard interconnection policies; procurement policies (e.g., state power purchases, loading order requirements, long-term contracting for clean DG resources, etc.); environmental disclosure, etc.

- **Goal levels:** Depends on specific policies to remove barriers.
- **Timing:** Depends on specific policies to remove barriers.
- **Parties:** Depends on specific policies to remove barriers.

Implementation Method(s):

- Varies depending on specific policies to remove barriers.

Related Policies/Programs in Place:

- None cited.

Type(s) of GHG Benefit(s):

- CO_2: By removing barriers to renewables and clean DG, more clean generation would enter the energy supply mix, displacing fossil fuel generation, and thereby reducing CO_2 emissions.
- Black Carbon: To the extent that removing barriers to renewables and clean DG lead to displacement of generation from coal and oil, black carbon emissions would decrease.

Estimated GHG Savings and Costs per tCO_2e:

- This option is quantified under RCI-6, Distributed Generation/Combined Heat and Power

Data Sources, Methods, and Assumptions:

- See RCI-6, Distributed Generation/Combined Heat and Power.

Key Uncertainties:

- See RCI-6, Distributed Generation/Combined Heat and Power.

Ancillary Benefits and Costs:

- Renewables and clean DG typically keep energy dollars in state, contributing more to employment, fuel diversity and security, and price stability for the state. Water use may be reduced through renewable versus combustion technologies.

Feasibility Issues:

- None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

ES-10 Metering Strategies

Policy Description:

There are two common metering strategies or policies: net metering and advanced metering. Net metering allows owners of grid-connected distributed generation resources (i.e., generating units on the customer side of the meter) to generate excess electricity and sell it back to the grid, effectively "turning the meter backward." This policy allows for low transaction costs (e.g., no need to negotiate contracts for the sale of electricity back to the utility) and is attractive to DG owners because they are compensated equal to the full cost of purchased electricity (i.e., the sum of wholesale generation, transmission and distribution, and utility administration costs) rather than just the utility's avoided costs.

Advanced metering technologies allow electricity consumers much greater opportunity to manage their electricity consumption. For example, consumers could set their meter to turn off or turn down air conditioning during the day while they are away. Coupled with pricing strategies that match prices to reflect actual costs during peak times, advanced metering could be set to automatically adjust demand by turning off lighting or appliances when real-time power prices reach a threshold set by the consumer. A policy could be put into place to encourage the use of advanced metering by subsidizing the meters or by mandating their installation.

Policy Design:

Net metering and advanced metering are enabling policies to encourage clean, distributed generation as opposed to reduction policies per se. Accordingly, the GHG reductions and costs associated with this policy option are automatically incorporated under RCI-6, Distributed Generation/Combined Heat and Power and RCI-7, Distributed Generation/Renewable Energy Applications.

- **Goal levels:** Not applicable.
- **Timing:** Not applicable.
- **Parties:** Utilities and utility customers.

Implementation Method(s):

- Information and education
- Technical assistance
- Funding mechanisms and or incentives
- Market-based mechanisms

Related Policies/Programs in Place:

- None cited.

Type(s) of GHG Benefit(s):

- CO_2: By encouraging more clean distributed generation through net metering, and lower demand through advanced metering, there would be less demand for CO_2-intensive central generation, leading to reductions in CO_2 emissions.
- Black Carbon: To the extent that net metering and reduced demand lead to less generation from coal and oil, black carbon emissions would decrease.

Estimated GHG Savings and Costs per tCO_2e:

- GHG reductions and costs for this enabling option are incorporated into the reductions reported under RCI-6, *Distributed Generation/Combined Heat and Power* and RCI-7, *Distributed Generation/Renewable Energy Applications*.

Data Sources, Methods, and Assumptions:

- Not applicable.

Key Uncertainties:

- None cited.

Ancillary Benefits and Costs:

- To the extent that metering strategies reduces fossil fuel generation, reductions in criteria air pollutant emissions and, consequently, health impacts and costs associated with those pollutants, would also occur.
- Water use may be reduced through renewable versus combustion technologies.

Feasibility Issues:

- None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

ES-11 Pricing Strategies

Policy Description:

Pricing strategies can take many forms including: *real-time pricing* in which utility customer rates are not fixed, but reflect the varying costs that utilities themselves pay for power; *"time-of-use" rates*, which are fixed rates for different times of the day and/or for different seasons; *"increasing block" rates* that are defined by blocks of consumption; *green pricing* whereby customers are given the opportunity to purchase electricity with a renewable or cleaner mix than the standard supply mix offered by the utility; and *advanced metering* to allow electricity consumers much greater opportunity to manage their electricity consumption.

Policy Design:

This policy was identified by both ES and RCI TWGs. In order to avoid duplicative effort, it was analyzed under RCI-8, Electricity Pricing Strategies.

- **Goal levels:** Not applicable.
- **Timing:** Depends on the specific policies.
- **Parties:** Utilities and utility customers.

Implementation Method(s):

- Market-based mechanisms

Related Policies/Programs in Place:

- See RCI-8, *Electricity Pricing Strategies*.

Type(s) of GHG Benefit(s):

- CO2: By encouraging less electricity consumption through pricing strategies, generation should be reduced, thereby reducing CO_2 emissions. Some pricing strategies, however, may have the impact of increasing CO_2 emissions.
- Black Carbon: To the extent that pricing strategies lead to less generation from coal and oil, black carbon emissions would decrease.

Estimated GHG Savings and Costs per tCO_2e:

- This option is quantified under RCI-8, *Electricity Pricing Strategies*.

Data Sources, Methods, and Assumptions:

- See RCI-8, *Electricity Pricing Strategies*.

Key Uncertainties:

- See RCI-8, *Electricity Pricing Strategies*.

Ancillary Benefits and Costs:

- See RCI-8, *Electricity Pricing Strategies*.

Feasibility Issues:

- See RCI-8, *Electricity Pricing Strategies*.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

ES-12 Integrated Resource Planning

Policy Description:

Integrated Resource Planning (IRP) is a process that diverges from traditional utility least-cost planning. Rather than simply focusing on supply-side options to meet a forecasted growth in electricity demand, IRP integrates technology and policy options on the demand side with supply-side options to satisfy the anticipated demand. Demand-side measures include energy efficiency, distributed generation, and peak-shaving measures. IRP typically also takes into account a broader array of costs, including environmental and social costs.

Policy Design:

IRP is an involved process that, by its nature as a bottom-up planning methodology at the utility level, does not lend itself to setting implementation levels per se. Quantifying CO_2 reductions under a policy mandating IRP would require, in effect, conducting integrated resource planning for all utilities in the State, which is beyond the scope of the CCAG process. However, a value can be assigned to emissions for use in the planning process. In the context of a climate-driven Arizona IRP, a “shadow price” per ton would be assigned to CO_2 emissions. In making decisions about which resources to use to satisfy demand for energy services, utilities would be required to apply this “shadow price” as a CO_2 adder in their evaluation of technologies and approaches. Utilities would not actually be required to pay this sum.

To quantify this option, the ES TWG applied a “shadow price” for CO_2, implemented in the fashion described below.

- **Goal levels:** Implement IRP with a CO_2 adder shadow price of $15 per ton of CO_2 emitted.
- **Timing:** Varies by individual utility generation profiles.
- **Parties:** Utilities and the ACC.

Implementation Method(s):

- Codes and standards

Related Policies/Programs in Place:

- No mandated IRP process is in use at this time in Arizona.

Type(s) of GHG Benefit(s):

- CO_2: IRP is a planning process that attempts to factor in the external cost of emissions, including CO_2; lower-emitting technologies are favored as a result. It also treats demand-side efficiency options as equal to supply-side options in the planning process, so fewer or smaller fossil fuel plants may be needed. The end result can be potentially significant CO_2 savings.
- Water use may be reduced through renewable versus combustion technologies.

- Black Carbon: To the extent that generation from coal and oil is reduced under IRP, black carbon emissions would also be reduced.

Estimated GHG Savings and Costs per tCO_2e:

#	Policy	Scenario	Reductions ($MMtCO_2e$) 2010	2020	Cumulative Reductions (2006-2020)	NPV (2006–2020) $ millions	Cost-Effective-ness $/$tCO_2$
ES-12	Integrated Resource Planning	$15/ton CO2 adder	0.06	5.4	28	-70	-2

The CCAG ultimately selected this policy option as one of its recommendations. The steps described in the final report were then taken to eliminate any potential overlap with other CCAG recommendations, because this could result in double-counting of costs and benefits. After considering what actions utilities would take in response to IRP with a $15 carbon adder, the ES TWG recommended and the CCAG determined that the same steps would already be driven by ES-1, *EPS/REST* and/or ES-6, *Carbon Intensity Targets*. Accordingly, all of the GHG reductions and cost savings provided by this policy would represent double-counting, and thus have not been counted in the overall GHG reduction or cost tallies of the ES TWG.

Data Sources, Methods and Assumptions:

- Data Sources: Data for the electricity modeling done for this analysis comes from the U.S. Energy Information Administration (EIA) and can be found within the National Energy Modeling System (NEMS). Data in NEMS includes representation of the existing generation, transmission and distribution system down to the unit level. NEMS also includes data that characterizes new plants that the model can choose to build to meet projected demand growth. EIA's publication entitled "*Assumptions to the Annual Energy Outlook*" details key assumptions in the current version of the model. EIA also publishes NEMS model documentation.

- Quantification Methods: As a proxy for the outcome of an IRP process, a tax of $15 per ton of CO_2 emitted was applied to electricity generators at the national level. CO_2 reductions were found by comparing emissions from the policy case to emissions from a reference case. Costs were estimated by comparing policy and reference case new generating capacity investments, operating and maintenance costs for all generation, fuel costs for all generation, and transmission and distribution costs for all generation. The reported cost for the policy is the net present value of the difference in the above costs between the policy and reference cases. Because the NEMS model captures the CO_2 tax in the price of fuel, the reference case price of fuel was simply substituted for the policy case price of fuel, which reflects the CO_2 tax. By making this assumption, the CO_2 tax is treated as a shadow price, i.e., the tax revenues are ignored, but investment and operating decisions are made as if there were a CO_2 tax in place. Because the NEMS model is a national model with multi-state regions (Arizona is within the Rocky Mountain Power Area), the results for Arizona were derived from results in the region. Regional emission and cost results were pro-rated according to the share of Arizona generation within the region.

- Key Assumptions: Any analysis of state-level policies using the National Energy Modeling System (NEMS) from the U.S. Energy Information Administration should be weighed carefully. NEMS is a national model that consists of 13 regions. State policies cannot be implemented explicitly within NEMS, and the State-specific impacts cannot be known explicitly. Assumptions must be made about the impact of policies at the State level by assigning shares of regional results. In reality, the State-level changes resulting from the policies implemented may differ substantially from the change in the region overall.

Key Uncertainties:

- Key uncertainties are related directly to the key assumptions and quantification methods listed above. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

- IRP attempts to take into account social costs including the impact on the economy as well as health impacts and costs related to criteria air pollution.

Feasibility Issues:

- None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

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Feasibility Issues:

- None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.